(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 181 203**
**A2**

(12) # EUROPEAN PATENT APPLICATION

(21) Application number: 85308072.9

(22) Date of filing: 06.11.85

(51) Int. Cl.⁴: B 21 D 47/01
B 21 C 37/15

(30) Priority: 06.11.84 GB 8428064

(43) Date of publication of application:
14.05.86 . Bulletin 86/20

(84) Designated Contracting States:
DE FR GB

(71) Applicant: BRITISH AEROSPACE PUBLIC LIMITED COMPANY
100 Pall Mall
London SW1Y 5HR(GB)

(72) Inventor: Stephen, David British Aerospace P.L.C.
Filton House Filton
Bristol Avon BS 99 7AR(GB)

(72) Inventor: Mansbridge, Martin Henry British Aerospace P.L.C.
Filton House Filton
Bristol Avon BS 99 7AR(GB)

(74) Representative: Saul, David Jonathan et al,
British Aerospace plc Corporate Patents Dept.
Brooklands Road
Weybridge Surrey KT13 0SJ(GB)

(54) **Forming complex hollow sectioned structural members.**

(57) A method is described of forming relatively complex I-sectioned tubular beam from relatively simple O-sectioned tubular stock either seamed or seamless provided that the material of the stock is superplastically deformable. The O-sectioned stock is sealed and filled with inert gas, heated to superplastic forming temperature and, in one embodiment, is placed in a mould which has regions inwardly movable to compress the stock into a desired shape, the gaseous pressure thus formed internally of the sealed stock causing the material of the stock to conform to the final interior shape of the mould. In a further embodiment the sealed, filled and heated stock is urged axially through a die which compresses the stock and is again constrained to conform with the final interior shape of the die by virtue of its internal gaseous pressure.

EP 0 181 203 A2

Croydon Printing Company Ltd.

0181203

# FORMING COMPLEX HOLLOW SECTIONED STRUCTURAL MEMBERS

Complex hollow sectioned structural members are difficult or impossible to extrude when they are formed by certain alloy materials; thus some other method of forming is necessary. At least some of these alloy materials are susceptible to superplastic deformation and, moreover, they can be supplied as tubular stock, either seamed or seamless. It is to this superplastically deformable tubular stock that the present invention relates.

It is thus an object of the present invention to provide a method of forming a structural member of relatively complex cross sectional shape from tubular stock or relatively simple cross section, for example the method of the invention allows a tubular or part-tubular generally I-section structural member to be formed from tubular stock of generally circular, rectangular, or other cross sectional shape in a relatively inexpensive and rapid manner.

According to the present invention a method of forming a structural member from tubular stock of superplastically deformable alloy material by using relative movement between at least some parts of constriction means and the tubular stock, the constriction means having interior surfaces which are shaped to provide a desired configuration at the final method step, including the not necessarily sequential steps of:-

(a) scaling the tubular stock to form a pressurisable envelope and filling the envelope with gas,

(b) introducing the stock into the constriction means,

(c) heating the stock to within the range at which superplastic deformation can take place, and subsequently to these steps,

(d) actively forcing at least some regions of the tubular stock inwardly against its interior gaseous pressure by relative movement of at least part of the constriction means and the tubular stock, whereby the interior pressure of the stock serves to hold the material of the stock against the interior surfaces of the constriction means and thus to cause it to adopt the final configuration thereof.

Where the constriction means comprise a mould with at least one inwardly movable region, the relative movement is effected by forcing the movable region from a position in which the tubular stock can be introduced into the mould to a final position in which the tubular stock is actively forced to adopt a final configuration.

Where the constriction means comprise a die having an aperture therethrough of cross-sectional shape changing from a shape into which the stock can be introduced to a final desired shape, the relative movement is effected by forcing the stock through the die whereby the stock is actively forced to adopt the final desired shape.

Some examples of a method according to the invention and apparatus for carrying out the method are described in the following drawings in which

Figure 1 is a cross sectional view of a tool with tubular stock ready to be formed,

Figure 2 is a similar view of the tool during forming,

Figure 3 is a similar view to that of the previous Figures but with the tool in a final forming position, and,

Figure 4 is yet a further similar view, but of an alternative arrangement.

Referring initially to Figures 1-3, a moulding tool comprises spaced upper and lower members 10, 11 having facing surfaces 12, 13 respectively. In between these surfaces are provided side members 14, 15 each having facing surfaces 16, 17 respectively. Urging means, not shown, are provided to urge the side members 14, 15 inwards towards each other in a controlled manner. The surfaces 12, 13 and 16, 17 form the interior of the mould and are thus shaped to form the final configuration of an article to be moulded when the side members are in the fully inward position.

In use a section 20 of tubular stock of superplastically deformable material is sealed at both ends and filled with an inert gas. It is placed in the mould when the side members 14, 15 are in the outward position. The section is conveniently of circular form, but other shapes can be utilised with effect. When heated to within the temperature range at which superplastic deformation can take place, the side members 14, 15 are urged inwards to contact and gradually deform the tubular stock. The gaseous pressure within the section of tubular stock causes the material thereof to be urged against the interior of the mould as illustrated in Figure 2.

The gaseous pressure is either the result of charging the section with a pressurised gas initally, or the residual pressure generated by the constriction effect of the mould side portions. Naturally it can also be a combination of both.

Figure 3 shows a final configuration where the side members 14, 15 are moved to their most inward position. In this postion, two opposed surfaces 16 -, 17- urge two regions of the circular sectioned stock (which regions were originally diametrically opposite of one another) together to form a double layered web of a generally I-sectioned beam. Where the material is suitable, diffusion bonding can be effected at this region by causing the side members 14, 15 to be sufficiently strongly urged to produce the necessary bonding pressure.

As can be seen in Figure 3, the final article is an I-sectioned beam with hollow flanges at the top and bottom joined by a double layered diffusion bonded web.

Referring now to the embodiment of Figure 4, a similar mould tool to that of the previous figures is provided, but is modified to have regions formed in the surfaces 12, 13 of the upper and lower members to accommodate capping members, 21, 22. These capping members are of diffusion bondable material so that when the material of the cylindrical stock 20 is urged against them under a suitable pressure exerted by the pressure within the stock section under the action of the urgeable side memembers 14, 15 diffusion bonding at regions 23, 24 takes place. Thus a reinforced I-section article can be formed.

The above methods and apparatus can be used to form constant or varying sectioned articles.

As an alternative to the moulding tool of the above figures which produces an article from a single section of the stock and is thus a batch process, it is possible to use the technique for a flow

process by replacing the mould tool with a die through which moving stock, having a pressure sealed interior is passed for forming. The die is of varying cross sectional area, for example, changing from that of Figure 1 at its inlet end to that of Figure 3 at its outlet end.

CLAIMS

1. A method of forming a structural member from tubular stock of superplastically deformable alloy material by using relative movement between at least some parts of constriction means and the tubular stock, the constriction means having interior surfaces which are shaped to provide a desired configuration at the final method step, including the not necessarily sequential steps of:-

(a) sealing the tubular stock to form a pressurisable envelope and filling the envelope with gas,

(b) introducing the stock into the constriction means,

(c) heating the stock to within the range at which superplastic deformation can take place, and, subsequently to these steps,

(d) actively forcing at least some regions of the tubular stock inwardly against its interior gaseous pressure by relative movement of at least part of the constriction means and the tubular stock, whereby the interior pressure of the stock serves to hold the material of the stock against the interior surfaces of the constriction means and thus to cause it to adopt the final configuration thereof.

2. A method according to claim 1 in which the constriction means comprise a mould with at least one inwardly movable region and the relative movement is effected by forcing the movable region from a position in which the tubular stock can be introduced into the mould to a final position in which the tubular stock is actively forces to adopt a final configuration.

3. A method according to claim 1 in which the constriction means comprise a die having an aperture therethrough of cross-sectional shape changing from a shape into which the stock can be introduced to a final desired shape and the relative movement is effected by forcing the stock through the die whereby the stock is actively forces to adopt the final desired shape.

Fig.1.

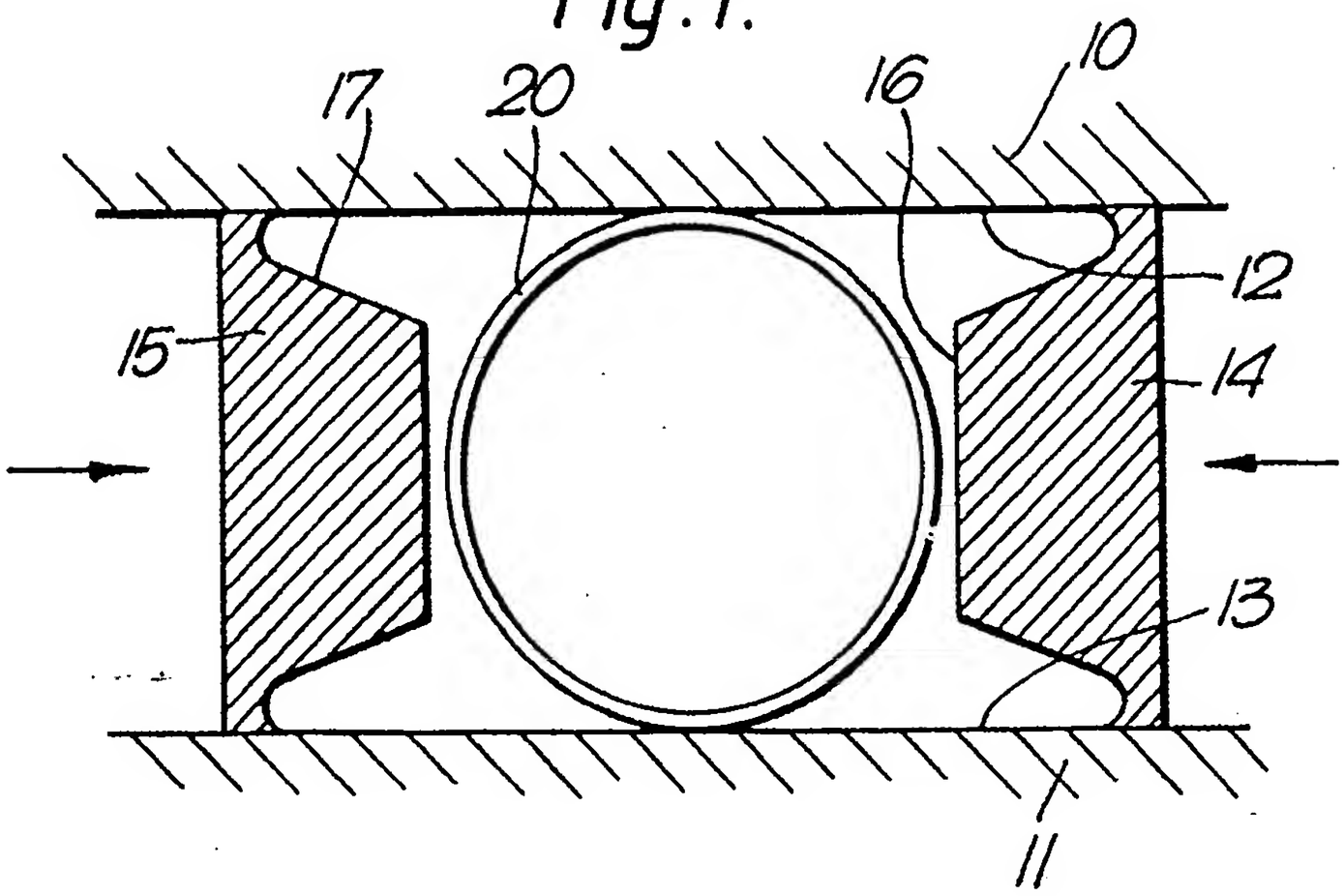



Fig.2.

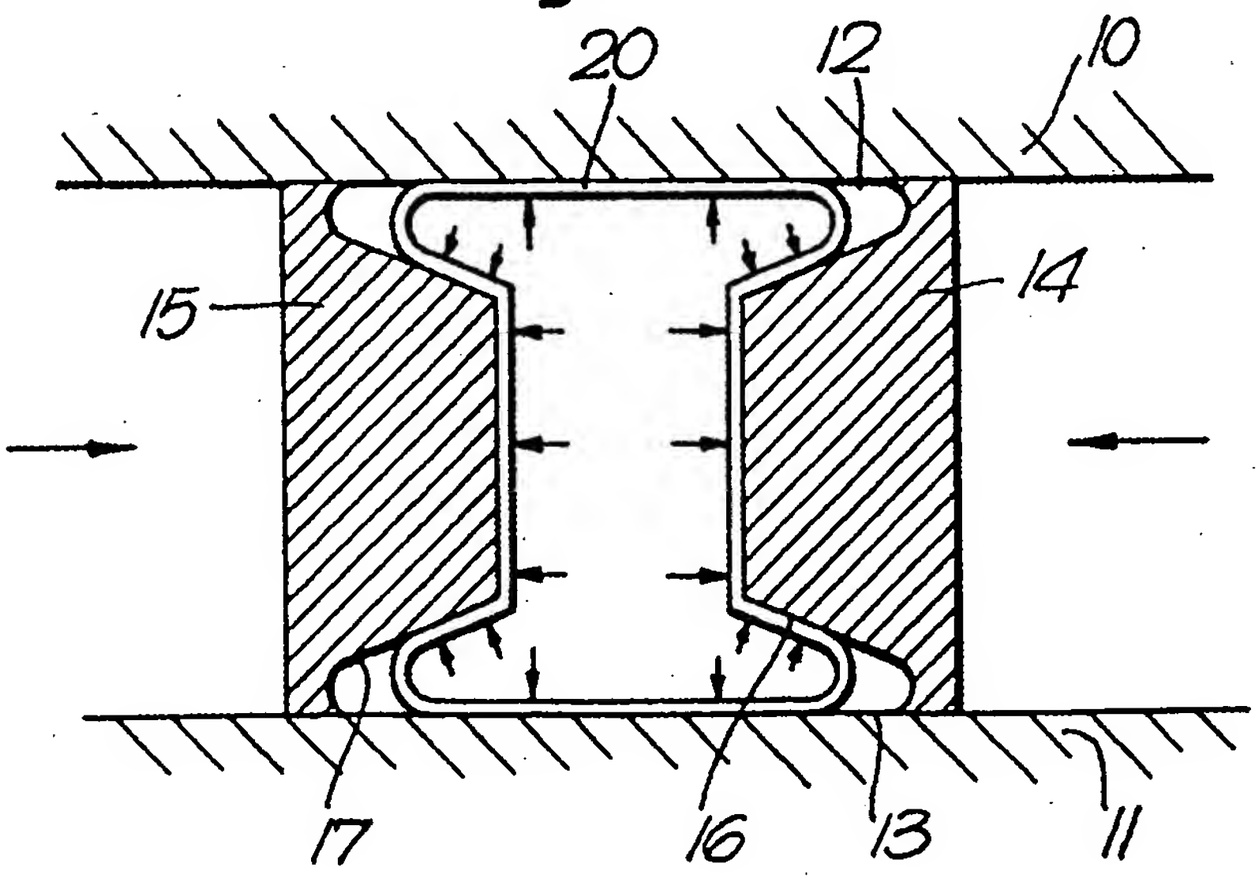


Fig.3.

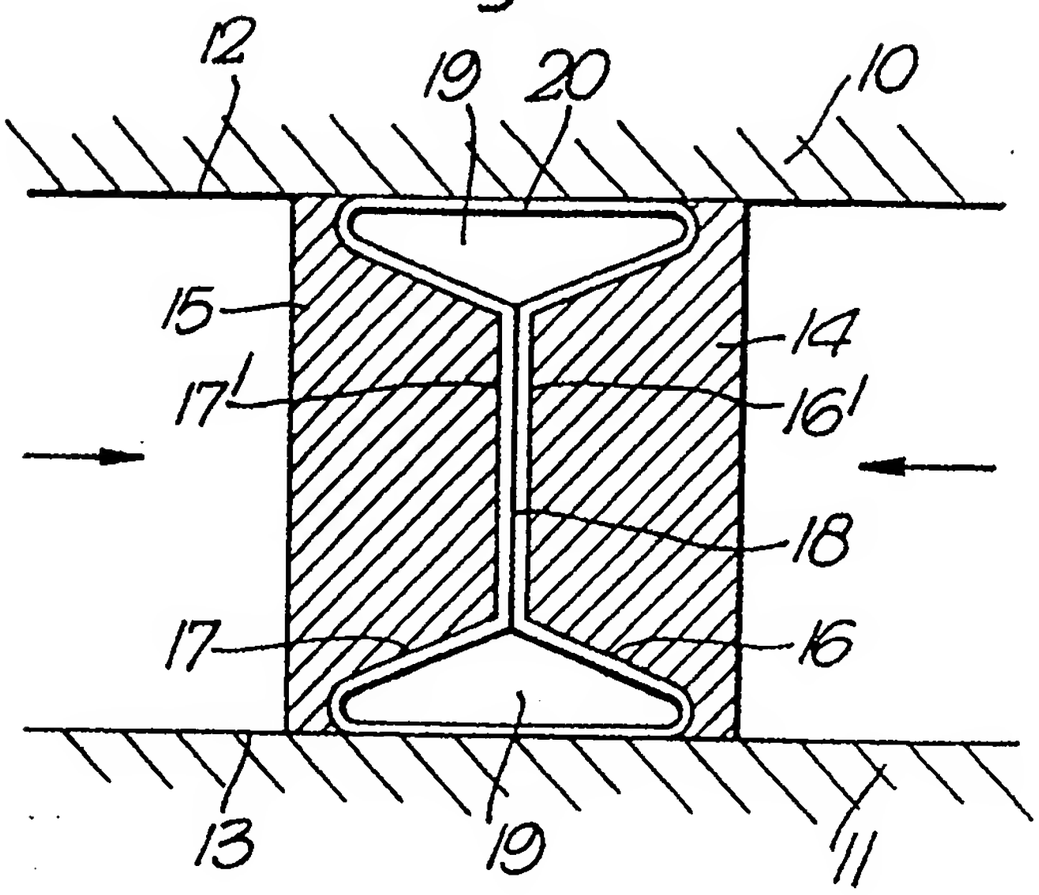
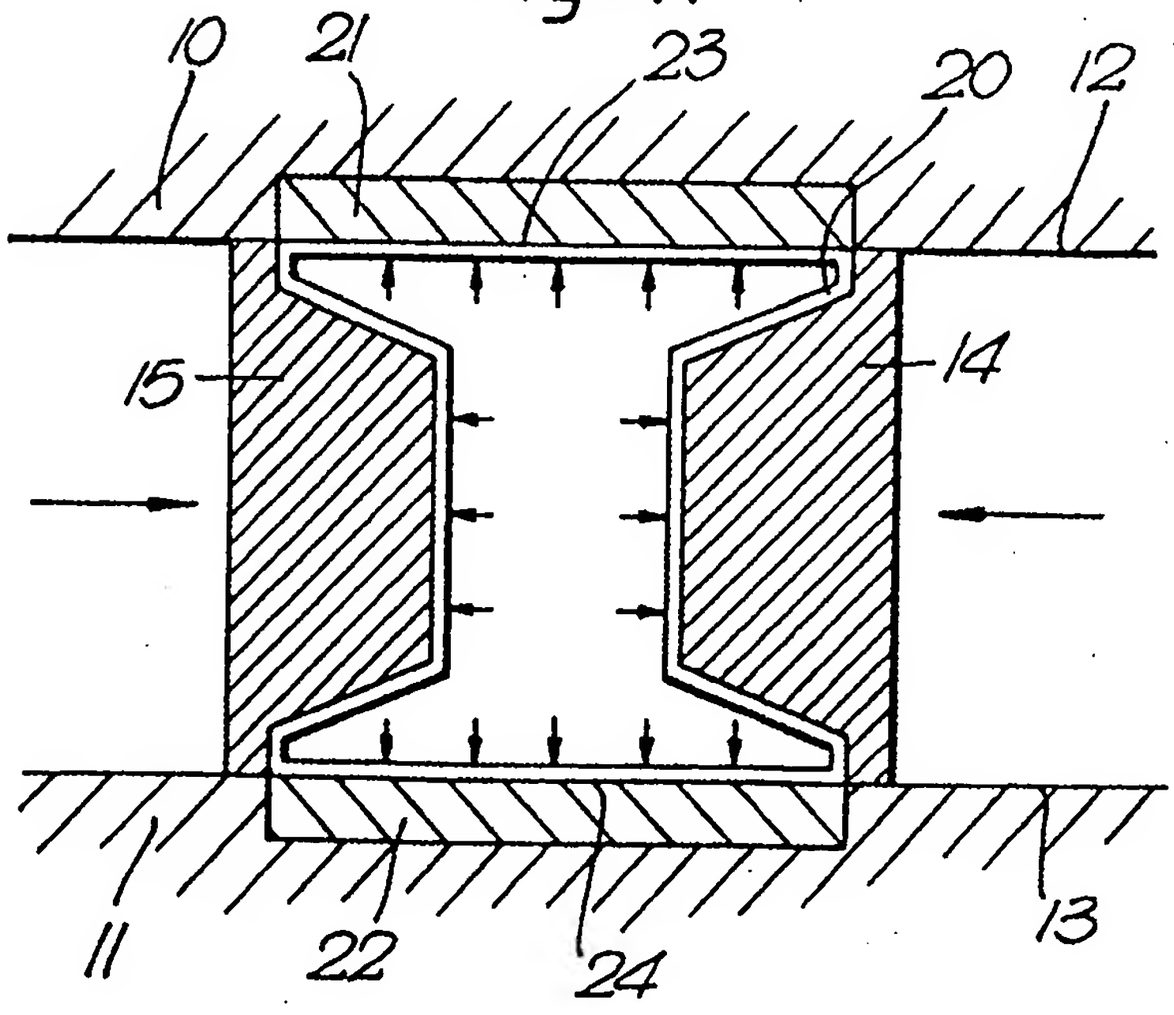

12
19
20
10
15
14
17'
16'
18
17
16
13
19
11

Fig.4.


10
21
23
20
12
15
14
11
22
24
13

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 181 203**
**A3**

# (12) EUROPEAN PATENT APPLICATION

(21) Application number: 85308072.9

(22) Date of filing: 06.11.85

(51) Int. Cl.⁴: **B 21 D 47/01**, B 21 C 37/15

(30) Priority: 06.11.84 GB 8428064

(43) Date of publication of application: 14.05.86 Bulletin 86/20

(84) Designated Contracting States: DE FR GB

(88) Date of deferred publication of search report: 21.01.87 Bulletin 87/4

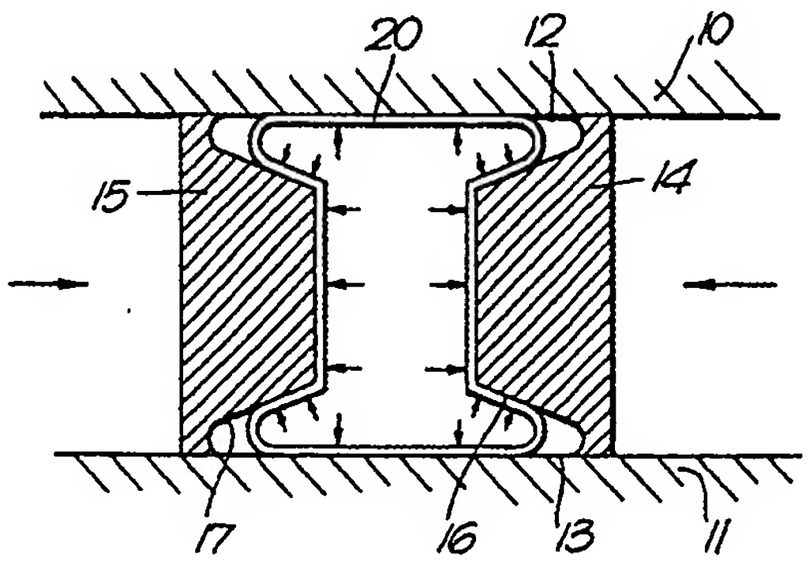
(71) Applicant: BRITISH AEROSPACE PUBLIC LIMITED COMPANY, 100 Pall Mall, London SW1Y 5HR (GB)

(72) Inventor: Stephen, David British Aerospace P.L.C., Filton House Filton, Bristol Avon BS 99 7AR (GB)
Inventor: Mansbridge, Martin Henry British Aerospace P.L.C., Filton House Filton, Bristol Avon BS 99 7AR (GB)

(74) Representative: Saul, David Jonathan et al, British Aerospace plc Corporate Patents Dept. Brooklands Road, Weybridge Surrey KT13 0SJ (GB)

## (54) Forming complex hollow sectioned structural members.

(57) A method is described of forming relatively complex I-sectioned tubular beam from relatively simple O-sectioned tubular stock either seamed or seamless provided that the material of the stock is superplastically deformable. The O-sectioned stock is sealed and filled with inert gas, heated to superplastic forming temperature and, in one embodiment, is placed in a mould which has regions inwardly movable to compress the stock into a desired shape, the gaseous pressure thus formed internally of the sealed stock causing the material of the stock to conform to the final interior shape of the mould. In a further embodiment the sealed, filled and heated stock is urged axially through a die which compresses the stock and is again constrained to conform with the final interior shape of the die by virtue of its internal gaseous pressure.




EP 0 181 203 A3

European Patent Office

# EUROPEAN SEARCH REPORT

0181203
Application number

EP 85 30 8072

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (Int. Cl.4) |
|---|---|---|---|
| A | GB-A-1 415 510 (BRITISH AIRCRAFT)<br>* claim 1 * | 1 | B 21 D 47/01<br>B 21 C 37/15 |
| A | DE-A-2 941 972 (THYSSEN)<br>* claim 1 * | 1 | |
| A | US-A-2 055 771 (LAUGHLIN)<br>* figure 1 * | 3 | |

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

B 21 D 22/00
B 21 D 26/00
B 21 D 47/00
B 21 C 37/00

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| BERLIN | 20-10-1986 | SCHLAITZ J |

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO Form 1503 03.82